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沿阶草亚科植物的叶表皮特征及其在分类学上的意义

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EPIDERMAL FEATURES OF LEAVES AND THEIR TAXONOMIC SIGNIFICANCE IN SUBFAMILY OPHIOPOGONOIDEAE (LILIACEAE)

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Abstract This paper reports epidermal features of leaves in Ophiopogonoideae. Thirty-nine species and one variety (29 species, 1 variety in *Ophiopogon*, 6 species in *Liriope*, 4 species in *Peliosanthes*) were examined under scanning electron microscope. In addition, transections of stomatal apparatuses of six species (*Ophiopogon*: 3 species; *Liriope*: 2 species; *Peliosanthes*: 1 species) were made and examined under light microscope.

The stomatal apparatus in *Liriope*, *Ophiopogon* and *Peliosanthes* is of the anomocytic type. These types of epidermal features of leaves in these genera are recognized: Cuticular processes type, No cuticular processes type and No stomatal band type. The cuticular processes type can be further divided into three patterns: Fibrillose, Massive and Wrinkled-massive. The taxonomic value of the epidermal features of leaves in Ophiopogonoideae is rather evident. (1) These epidermal features can be used to distinguish among those species of *Ophiopogon*, *Liriope* and *Peliosanthes*, even in their vegetative state; (2) The different patterns of cuticular processes are helpful to reasonable classification of some species in *Ophiopogon*, (3) They are of great value for recognizing some sections, (4) These epidermal features of leaves also provide evidence for further discussion on relationships among *Ophiopogon*, *Liriope*, and *Peliosanthes*.

The evolutionary trend of the epidermal features of leaves in Ophiopogonoideae is No stomatal band type→ No cuticular process type(stomatal band)→ Cuticular process type (stomatal band). According to the epidermal features of leaves, flowers and fruits, *Ophiopogon*, *Liriope* and *Peliosanthes* are closely related, forming a subfamily Ophiopogonoideae. *Ophiopogon* is more close to *Liriope* than to *Peliosanthes*, and they

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本文承汤彦承、胡玉熹同志提出宝贵意见，肖荫厚、张和民、高德禄等同志在扫描电镜观察时给予技术上的指导，顾立民同志帮助制作叶片横切面切片，在此一并表示感谢。

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should be grouped into the same tribe—Ophiopogoneae. *Liriope* seems to be more primitive than *Ophiopogon*. *Peliosanthes*, which constitutes another tribe of its own—Peliosantheae, is more advanced than *Ophiopogon* and *Liriope*, and it might have been derived from its ancestor early.

Key words Ophiopogonoideae; Ophiopogoneae; Peliosantheae; *Ophiopogon Liriope*; *Peliosanthes*; leaf epidermis; taxonomy.

摘要 本文用扫描电镜和光学显微镜观察研究了沿阶草亚科(Ophiopogonoideae)3属39种1变种叶片远轴面的表皮特征。认为这些气孔器周围的邻近细胞和表皮细胞特征在分类上有比较重要的意义，主要是:(1)有助于沿阶草属、山麦冬属和球子草属种间和属间种类的鉴别;(2)给这些植物类群的分类提供了有用的性状;(3)对沿阶草属的归类有着比较重要的意义;(4)为探讨沿阶草亚科内3个属间的亲缘关系提供了有益的证据。并认为，这三个属的气孔器邻近细胞和表皮细胞特征的演化趋势为无气孔带类型→无角质突起类型→具角质突起类型(具气孔带)。根据这些特征和外部形态性状认为这三个属的亲缘关系比较密切，应归属于同一个大类群——沿阶草亚科。

关键词 沿阶草亚科;沿阶草族;球子草族;沿阶草属;山麦冬属;球子草属;叶表皮;分类学。

沿阶草亚科植物分布于亚洲，中国种类最多，主要分布于长江流域以南各省区，华北只有少数栽培的种类，它包括三个属，即山麦冬属(*Liriope* Lour.)、沿阶草属(*Ophiopogon* Ker-Gawl.)和球子草属(*Peliosanthes* Andr.)。近代的一些植物分类学家对这一类群植物的归类有不同的意见。Krause(1930)的系统是将这三个属归属于广义百合科的沿阶草族(Ophiopogoneae)。Hutchinson(1959, 1973)认为沿阶草属和山麦冬属的果实为室背或室间开裂的蒴果而归属于沿阶草族，球子草属的果实为不规则开裂的浆果，而属于另一个族球子草族(Peliosantheae)，均归属于广义的百合科。后来Thorne(1968, 1976)在广义的百合科之下成立了沿阶草亚科。Dahlgren等(1985)将这三个属归属于同一个族沿阶草族，分属于从百合科中分出的铃兰科(Convallariaceae)。Takhtajan(1987)则将这三个属归属于铃兰科的沿阶草亚科。作者认为这三个属的果实是一样的，均为早期开裂的蒴果，种子浆果状，裸露，是一比较自然的类群，现试图从其叶表皮特征来辅助外部形态进一步探讨这三个属的合理归类。

材 料 与 方 法

作者共观察了沿阶草属植物29种1变种，山麦冬属6种，球子草属4种(见附录)，均取样于中国科学院植物研究所植物标本馆的标本和一部分温室内栽培的新鲜植物，取其成长好的叶片靠近中脉部分约4[mm]^{2}面积，置于95%酒精中浸洗10分种，取出晾干，用两面胶纸黏置于观察台上，经镀膜后，移入S-450、S-800型扫描电镜下观察，并选择完整的部位进行照相。同时还对干的和新鲜的叶片，同一种不同植株的叶片的表皮特征都做了观察和比较。

另外还将沿阶草属中的三个种多花沿阶草(*Ophiopogon tonkinensis* Rodr.)、厚叶沿阶草(*O. corifolius* Wang et Dai)和长茎沿阶草(*O. chingii* Wang et Tang)，山麦冬属的

阔叶山麦冬(*Liriope platyphylla* Wang et Tang)和禾叶山麦冬 *L.graminifolia*(L.)Baker)以及球子草属的匍匐球子草(*Peliosanthes sinica* Wang et Tang)共 6 种作了叶片横切面切片,方法是先将干叶片用蒸馏水浸泡,再用沸水泡软(时间视材料而定),然后用 FAA 固定液固定 12 小时,取出用蒸馏水冲洗数次,按常规方法脱水切片,厚度 8—10μm,最后用 PAS 反应染色,封存。

观 察 结 果

经过扫描电镜和光学显微镜的观察结果(表 1)为:

1. 干的和新鲜的叶片,同一种不同植株上的叶片的气孔器和表皮特征是一致的。

2. 这三个属植物的叶片只有在远轴面上有气孔,沿阶草属和山麦冬属多数种类气孔或密或疏地排列成带,山麦冬属少数种类和球子草属气孔不明显排列成带状。

3. 这三个属的气孔器均属于无规则型(Anomocytic type)(见图 1),邻接保卫细胞周围的 4 个细胞与其周围的表皮细胞的形状一样,称之邻近细胞,以区别于其他表皮细胞。

4. 邻近细胞和气孔带内的表皮细胞表面有的种类明显隆起(图 1:5)有的种类不明显隆起(图 1:3,4);表面角质层增厚,平滑或具各种形状的角质突起。

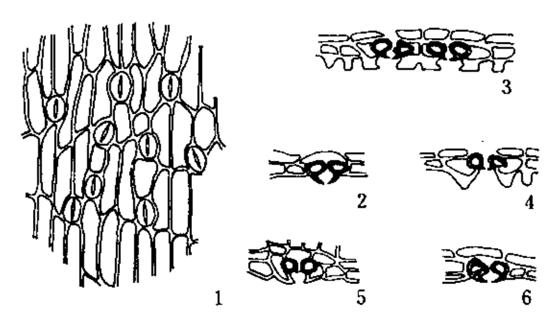


图 1 1. 长药沿阶草叶片表面,示叶片远轴面的气孔器及周围表皮细胞。
2—6. 叶片远轴面气孔器的横切面,示角质突起或隆起的邻近细胞。
2. 阔叶山麦冬,3. 厚叶沿阶草,4. 长茎沿阶草,5. 禾叶山麦冬,6. 匍茎球子草.

Fig.1 1. The abaxial leaf surface of Ophiopogon peliosanthoides Wang et Tang, showing the stomatal apparatus and epidermal cells surrounding it.
2—6. Transection of the stomatal apparatus on the abaxial leaf surface, showing the cuticular processes or prominent neighbouring cells.
2. *Liriope platyphylla*, 3. *Ophiopogon corifolius*, 4. *O.chingii*, 5. *L.graminifolia*, 6. *Peliosanthes sinica*.

从表 1 可见叶片表皮特征可归为 3 个类型,其中具角质突起类型又可分为 3 个型式,具体如下:

1. 具角质突起类型(Cuticular process type) 邻近细胞不明显隆起,邻近细胞和气孔带内的表皮细胞表面具各种形状角质突起,气孔呈下陷状,气孔带明显,沿阶草属绝大多数种类为此类型。根据角质突起的特征分为三种型式:

(1)细纤维状型式(Fibrillose pattern),气孔周围邻近细胞表面有由细纤维状结构组成的各种形状角质突起,气孔带内的表皮细胞表面具圆形的同样结构的角质突起,成行排列或星散分布,周围具松散的细纤维结构;气孔带很宽→宽(大多数种类为很宽,个别种类为狭的),气孔带间距为狭→很狭,个别种类为宽的(图版 1:1—3;图版 2:16, 17;图版 3:19,

表1 山麦冬属、沿阶草属、

Table 1 Comparison of the abaxial epidermal features of

属和组 Genus and Section	表皮特征型式 Pattern of epidermal features	特征 Characters / 种类 Species	气孔带宽度 Breadth of stomatal band	气孔带间距 Distance between stomatal bands	保卫细胞表面特征 Surface features of guard cells
沿阶草属 *Ophiopogon* 沿阶草组 Sect. Ophiopogon	具角质突起类型 Cuticular processes type 细纤维状型式 Fibrillose pattern	异药沿阶草 *Ophiopogon heterandrus*	wide	wide	with dense and fine hair-shaped processes
		匍茎沿阶草 *O. sarmentosus*	very wide	very narrow	ditto
		长药沿阶草 *O. peliosanthoides*	ditto	narrow	ditto
		云南沿阶草 *O. tienensis*	ditto	ditto	with sparse and fine hair-shaped processes
		钝叶沿阶草 *O.amblyphyllus*	ditto	ditto	ditto
		长茎沿阶草 *O. chingii*	wide to very wide	narrow to wide	with dense and fine hair-shaped processes
		棒叶沿阶草 *O. clavatus*	very wide	narrow	with sparse and fine hair-shaped processes
		屏边沿阶草 *O. pingbienensis*	ditto	very narrow	smooth
		卷瓣沿阶草 *O. revolutus*	wide	ditto	with dense and fine hair-shaped processes
		厚叶沿阶草 *O. corifolius*	very wide	very wide	with sparse and fine hair-shaped processes
		间型沿阶草 *O. intermedius*	narrow	narrow	with dense and fine hair-shaped processes
		麦冬 *O. japonicus*	ditto	ditto	ditto
沿阶草属 *Ophiopogon* 簇生叶组 sect. Fasciculatis	具角质突起类型 Cuticular processes type 块状型式 Massive pattern	褐鞘沿阶草 *O. dracaenoides*	ditto	very wide	smooth
		多花沿阶草 *O. tokinensis*	ditto	wide	ditto
		木根沿阶草 *O. xylorrhizus*	ditto	ditto	with sparse and fine hair-shaped processes
		广东沿阶草 *O. reversus*	very narrow to narrow	narrow	with dense and fine hair-shaped processes
		阴生沿阶草 *O. umbraticola*	narrow	wide	ditto
		姜状沿阶草 *O. zingiberaceus*	very narrow to narrow	narrow to wide	with sparse and fine hair-shaped processes
		富宁沿阶草 *O. fooningensis*	very narrow	wide	with dense and fine hair-shaped processes
		簇叶沿阶草 *O. tsaii*	ditto	narrow to wide	with sparse and fine hair-shaped processes

球子草属叶片下表皮特征的比较
leaves in Liriope, Ophiopogon and Peliosanthes

邻近细胞及其表面特征 Neighbouring cells and their surface features	表皮细胞表面特征 Surface features of epidermal cells
indistinctly prominent, with 4—6 globulose or oblong cuticular processes composed of fibriform structure	with dense globulose cuticular processes composed of fibriform structure, surrounded by loose fibriforn structure
indistinctly prominent, with 4 oblong cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 6 oblong or elliptic cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 4—5 elliptic cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 4 oblong, more or less connected cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 4—6 globulose or elliptic cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with cyclic cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 4 oblong, more or less connected cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 5—6 globulose cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 4 oblong or elliptic cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 4—6 globulose or oblong cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 6—8 globulose cuticular processes composed of fibriform structure	ditto
indistinctly prominent, with 4 irregular–massive cuticular processes	with dense, irregular–massive cuticular processes, arranged in rows, surrounded by sparse and fine processes
ditto	with dense, irregular–massive cuticular processes, arranged in rows, not surrounded by fine processes
indistinctly prominent, with 6 irregular–massive cuticular processes	with dense, irregular–massive cuticular processes, arranged in rows, surrounded by fine hair–shaped processes
indistinctly prominent, with 4 irregular–massive cuticular processes, more or less connected	ditto
ditto	ditto
ditto	ditto
indistinctly prominent, with 4 irregular–massive cuticular processes, more or less connected	ditto
ditto	ditto

属和组 Genus and Section	表皮特征型式 Pattern of epidermal features	特征 Characters / 种类 Species	气孔带宽度 Breadth of stomatal band	气孔带间距 Distance between stomatal bands	保卫细胞表面特征 Surface features of guard cells
同前 ditto	同前 ditto	林生沿阶草 *O. sylvicolus*	very with	very narrow	ditto
		宽叶沿阶草 *O. platyphyllus*	wide	very wide	ditto
		大沿阶草 *O. grandis*	wide	narrow to wide	ditto
沿阶草属 *Ophiopogon* 连药组 Sect. Synantheri	具角质突起类型 Cuticular processes type 褶皱块状型式 Wrinkled-massive pattern	粉叶沿阶草 *O. glaucifolius*	very wide	very narrow	with dense and fine hair-shaped processes
		四川沿阶草 *O. szechuanensis*	wide	narrow	ditto
		连药沿阶草 *O. bockianus*	ditto	ditto	ditto
		短药沿阶草 *O. bockianus* var. *angustifolius*	ditto	ditto	ditto
		西南沿阶草 *O. mairei*	narrow	narrow	with sparse and fine processes
沿阶草属麦冬组 *Ophiopogon* Sect. Bodinieri	无角质突起类型 Non-cuticular processes type	沿阶草 *O. bodinieri*	ditto	ditto	with dense and fine hair-shaped processes
		长叶沿阶草 *O. wallichianus*	ditto	ditto	smooth
山麦冬属 *Liriope*	无角质突起类型 Non-cuticular processes type	矮小山麦冬 *Liriope minor*	ditto	ditto	ditto
		长梗山麦冬 *L. longipedicellata*	very narrow	ditto	with sparse and fine hair-shaped processes
		禾叶山麦冬 *L. graminifolis*	ditto	ditto	smooth
		甘肃山麦冬 *L. kansuensis*	ditto	ditto	with sparse and fine hair-shaped processes
	无气孔带类型 Non-stomatal band type	山麦冬 *L. spicata*	indistinct	indistinct	with sparse and fine processes
		阔叶山麦冬 *L. platyphylla*	ditto	ditto	smooth
球子草属 *Peliosanthes*	无气孔带类型 Non-stomatal band type	长苞球子草 *Peliosanthes ophiopogonoides*	indistinct	indistinct	smooth
		大盖球子草 *P. macrostegia*	ditto	ditto	ditto
		簇花球子草 *P. teta*	ditto	ditto	ditto
		匍茎球子草 *P. sinica*	ditto	ditto	ditto

under 150um = very narrow, 151—300um = narrow, 301—550um = wide, above 550um = very wide

续表 1

邻近细胞及其表面特征 Neighbouring cells and their surface features	表皮细胞表面特征 Surface features of epidermal cells
indistinctly prominent, with 4 oblong-massive cuticular processes	with globulose or oblong-massive cuticular processes, arranged in rows, surrounded by hair-shaped processes
ditto	ditto
indistinctly prominent, with 4 irregular-massive cuticular processes, usually connected	with globulose-massive cuticular processes, arranged in rows, surrounded by fibriform processes
indistinctly prominent, with 6—8 wrinkled-massive cuticular processes	with wrinkled-massive cuticular processes more or less connected between two, surrounded by dense hair-shaped processes
ditto	ditto
indistinctly prominent, with 4 wrinkled-massive cuticular processes	ditto
ditto	ditto
ditto	ditto
distinctly prominent, with thickened cuticle and fine hair-shaped processes	distinctly prominent, with thickened cuticle and fine hair-shaped processes
distinctly prominent, with thickened cuticle, smooth	distinctly prominent, with thickened cuticle, smooth
ditto	ditto
distinctly prominent, with thickened cuticle and fine hair-shaped processes	distinctly prominent, with thickened cuticle and fine hair-shaped processes
distinctly prominent, with thickened cuticle, smooth	distinctly prominent, with thickened cuticle, smooth
distinctly prominent, with thickened cuticle and fine hair-shaped processes	ditto
indistinctly prominent, smooth	indistinctly prominent, smooth
ditto	ditto
indistinctly prominent, smooth	indistinctly prominent, smooth
ditto	ditto
ditto	ditto
indistinctly prominent, with thickened cuticle and striations	indistinctly prominent, with thickened cuticle and striations

20,26)。

(2)块状型式(Massive pattern),气孔周围邻近细胞表面具近圆形或不规则形块状的角质突起,气孔带内的表皮细胞表面也具近圆形或不规则形小块状的角质突起,两块之间常部分连接,周围被密的或疏的毛状小突起,极少数种类为平滑;气孔带为狭→很狭,个别为宽的,气孔带间距多数为宽的,极少数为狭的(图版 1:7; 图版 3: 21—24)。

(3)褶皱块状型式(Wrinkled-massive pattern),气孔周围邻近细胞表面有具褶皱的块状角质突起,气孔带内的表皮细胞表面具同样形状小块状角质突起,两块之间部分连接,周围被密的毛状小突起;气孔带为宽→很宽(大多数种类为宽),极个别为狭(图版 1:4,6,9; 图版 2: 13; 图版 3: 25)。

2. 无角质突起类型(No cuticular process type) 邻近细胞和气孔带内的表皮细胞表面明显隆起,角质层增厚或稍增厚,无各种形状角质突起,表面平滑或被毛状小突起,气孔呈下陷状;气孔带狭,气孔带间距狭。山麦冬属多数种类和沿阶草属少数种类为此类型(图版 1: 5、8; 图版 2: 14、18; 图版 3: 27)。

3. 无气孔带类型(No stomatal band type) 邻近细胞和周围表皮细胞表面不隆起,无各种形状角质突起,个别种类角质层增厚,具条纹,气孔不呈下陷状;气孔不明显成带。球子草属的种类和山麦冬属少数种类为此类型(图版 2:10—12,15)。

讨论

根据这三属植物叶片表皮特征的扫描电镜和横切面的光学显微镜观察结果,这一类群植物的气孔器均为无规则型,但其邻近细胞和表皮细胞及其表面特征不同,在系统分类上是可以作为归类的依据。主要是:

(一)有助于沿阶草属种类以及这三个属属间种类的鉴别。由于这三个属植物根据其营养器官的性状常常难于区别,不但同属内的不同种类,甚至不同属的植物亦不易鉴别,但通过对叶片表皮特征的观察和比较,就可以明显地区别开来,一般在高倍解剖镜或光学显微镜下即可辨认出来,例如麦冬(*Ophiopogon japonicus* (L.) Ker-Gawl.)、沿阶草(*O.bodinieri* Levl.)和间型沿阶草(*O.intermedius* D. Don),其营养器官的外形十分相似,无花的标本很难鉴别,但根据叶片表皮特征就可以很容易地区别开了(图版 1:3; 图版 2:16,18)。又如沿阶草属具叶柄的种类与球子草属植物之间的区别,沿阶草属具禾叶状叶的种类与山麦冬属植物之间的区别亦可以根据其叶片远轴面表皮特征给予比较准确的鉴定,但同属内有些种类叶片表皮特征也比较相似,需要仔细观察加以区别。

(二)这三个属的叶片远轴面表皮特征给这些类群植物的分类提供了十分有用的性状,我们比较了一些种与种间、种与变种之间的叶片表皮特征,改变了原来的归类,使新的归类更为合理一些。例如原来将叶较宽、厚而质硬、花大的一些沿阶草属植物标本均归在间型沿阶草种内,认为是种内变异的范围,然而根据其叶片表皮特征,前者为无角质突起类型(图版 1:5),而间型沿阶草则为具角质突起类型中的细纤维状型式(图版 1:3),再根据其外部形态特征,前者应鉴定为印度沿阶草(*Ophiopogon wallichianus* Hook.f.)。又如在中国植物志第十五卷中定名为粉叶沿阶草(*O. chingii* Wang et Tang var. *glaucifolius* Wang et Dai)的一个变种,其叶片表皮特征为具角质突起类型

中的褶皱块状型式(图版 1:6;图版 2:13),而长茎沿阶草(*O. chingii* Wang et Tang)的为细纤维状型式(图版 2:17),在观察其他变种与其所归属的种,它们的叶片表皮特征一般都属同类型,因此粉叶沿阶草应成立为另一个种为宜.即(*Ophiopogon glaucifolius* (Wang et Dai) Dei et Liang)。

(三)对沿阶草属的分组有着重要的意义。本属营养器官和繁殖器官的各种性状作为进一步归类时都有些种类难于归属,中国植物志第十五卷上把沿阶草属分为两个组,一为宽叶组(Sect. Peliosanthoides Wang et Dai),包括 12 种,一为沿阶草组(Sect. Ophiopogon),包括 21 种。宽叶组的种类,叶明显具柄,叶片各种形状;沿阶草组的种类叶具鞘,叶片禾叶状;这样的归类从花的外部形态特征来看是比较不一致的,因此参考比较稳定的叶片表皮特征对属内种类进行合理归类就有很大帮助。同时进行这样的归类有助于进一步研究种间的亲缘关系及演化趋势,例如麦冬、沿阶草、间型沿阶草三个种很近似,而麦冬的花柱为宽而扁的,与其他两种不一样,但从叶片表皮特征类型来看,麦冬则更近似间型沿阶草,而沿阶草的叶片表皮特征是与山麦冬属的一些种类相近,根据这些特征的演化趋势,可以认为沿阶草则是沿阶草属中比较原始的种,而麦冬与间型沿阶草是为较进化的类群。现根据其叶片表皮特征和外部形态性状分为四个组和一些亚组。

1. 沿阶草组 Sect.Ophiopogon,花一般较大,花被片长多在 7mm 以上,叶片表面为具角质突起类型中的细纤维状型式的种类(见表 1)。

(1)匍茎亚组 Subsect。Peliosanthoides (Wang et Dai) Dai et Liang——Sect.Peliosanthoides Wang et Dai),茎一般较长,叶具柄,叶片为各种形状。

(2)沿阶草亚组 Subsect.Ophiopogon ,茎短,叶为禾叶状。

2. 簇生叶组 Sect.Fasciculatis Dai et Liang,花一般较小,花被片长多在 6mm 以下,叶片表皮为具角质突起类型中的块状型式的种类(见表 1)。

(1)宽叶亚组 Subsect.Latifolii Dai et Liang,茎一般较长,叶成簇着生于节上,具柄,叶片为各种形状。

(2) 禾叶亚组 Subsect. Graminifolii Dai et Liang ,茎短或稍长,叶为禾叶状。

3. 连药组 Sect。Synantheri Dai et Liang,花一般中等大,花被片长 6—8mm,花药常连合成筒状,叶片表皮特征为具角质突起类型中的褶皱块状型式的种类(见表 1)。

4. 拟山麦冬组 Sect.Bodinieri Dai et Liang、花较小,花被片长 6mm 以下,叶片禾叶状,叶片表皮特征为无角质突起型式(见表 1)。

(四)为探讨沿阶草属、山麦冬属和球子草属的亲缘关系提供了有益的证据。现将这三个属的一些主要性状比较如下(见表 2):

按照一般植物器官的演化趋势是:子房上位→子房半下位,花丝分离、基部不增粗
→ 花丝分离,基部增粗
→ 花丝合生成内弯的环,花被片离生→花被片基部合生,叶禾叶状→叶具各种形状。同时本研究观察到的叶片远轴面表皮特征的演化趋势应为无气孔带类型→无角质突起类型(具气孔带)→具角质突起类型,因此这三个属之间的亲缘关系是:

1. 它们之间有着比较密切的联系,应该属于同一个大的类群。从叶片表皮特征比较,山麦冬属有两种类型,一种为无角质突起类型,这种类型与沿阶草属的沿阶草一类是很相

表 2 山麦冬属、沿阶草属、球子草属主要性状比较表

Table 2 The comparison of the principal characters in *Liriope*, *Ophiopogon* and *Peliosanthes*.

属 Genus / 特征 Characters	山麦冬属 *Liriope*	沿阶草属 *Ophiopogon*	球子草属 *Peliosanthes*
果实 Fruit	蒴果，早期开裂 capsule, soon rupturing	蒴果，早期开裂 capsule, soon rupturing	蒴果，早期开裂 capsule, soon rupturing
种子 Seed	裸露，浆果状 exposed, berry-like	裸露，浆果状 exposed, berry-like	裸露，浆果状 exposed, berry-like
子房 Ovary	上位 superior	半下位 semi-inferior	半下位 semi-inferior
花丝 Filaments	分离，基部不增大 free, not expanded at base	分离，粗短，基部增大 free, expanded at base	连合成内弯的环 connected into an incurved annulus
花被片 Tepals	分离 free	分离 free	下部合生 connate in the lower part
叶 Leaf	叶具鞘，叶片禾叶状 vaginated, graminaceous-like blade	叶具鞘，叶片禾叶状或叶具柄，叶片各种形状、vaginated, blade graminaceous-like or long-petiolate and blade various in shapeo	叶具长柄，叶片为各种形状 long-petiolate, blade various in shape
气孔带 Stomatal band	明显或不明显 distinct or indistinct	明显 distinct	不明显 indistinct
气孔器类型 Type of stomatal apparatus	无规则型 anomocytic type	无规则型 anomocytic type	无规则型 anomocytic type
角质突起 Cuticular process	无角质突起 No cuticular processes	具角质突起 with cuticular processes except in a few species	无角质突起 No cuticular processes
邻近细胞和表皮细胞 Neighbouring cells and epidemal cells	明显或不明显隆起 distinctly prominent or indistinctly prominent	不明显隆起，少数种类隆起 indistinctly prominent or distinctly prominent in a few species	不明显隆起 indistinctly prominent
茎 Stem	合轴 sympodial	合轴 sympodial	合轴 sympodial
根 Root	有时具小块根 sometimes with root tubers	有时具小块根 some times with root tubers	无小块根 without root tubers

似的(图版 1:5,8;图版 2:18);另一是无气孔带类型(图版 2:10.11),与球子草属的相同(图版 2:12,15)。而且它们的果实早期开裂,并裸露出浆果状的种子,以及茎的生长方式均为合轴式的性状均为一致的。Hutchinson(1959)认为球子草属的果实为不规则破裂的浆果,而有别于山麦冬属和沿阶草属室背或室间开裂的蒴果。Dahlgren(1985)提到山麦冬属和沿阶草属的果实时,称它们的果实为不规则破裂的蒴果。根据目前植物标本上观察到的情况,三个属的果实则是相同的,由于果实在尚未成熟时就被浆果状的种子所胀破而成不规则的破裂,不像一般成熟的蒴果在室背或室间规则地开裂。根据以上一些共同的特性,这三个属之间有着比较近的亲缘关系。

2. 球子草属是较进化的一支,但它也是较早分出的一支,虽然它的花比较特化,花被片基部合生,花丝连合成环状,子房半下位等均为进步的性状,但它的叶片表面特征仍保留着较其他两属为原始的类型——无气孔带类型。

3. 山麦冬属与沿阶草属的亲缘关系更为密切,山麦冬属较沿阶草属为原始的类群。山麦冬属中大多数种类叶片表皮特征为无角质突起类型,与沿阶草属个别种类的叶片表皮特征十分相似,它们的花的构造也很近似,如花丝分离,花被片基部不合生;禾叶状的叶以及两属都有种类具小块根等性状均很相似;但沿阶草属绝大多数种类叶片表皮特征均为具角质突起类型,其花的构造子房半下位,花丝基部增大等特征均较山麦冬属为进步,因此这两属的亲缘关系更接近,沿阶草属较山麦冬属为进步。

4. 这三个属应该归属于同一亚科沿阶草亚科,而分属于两个族,沿阶草属和山麦冬属归属于沿阶草族,球子草属归属于球子草族。至于沿阶草亚科应属于铃兰科,还是狭义的百合科,还有必要作进一步的研究。

附录(Appendix):材料来源(Origin of the material)

Ophiopogon heterandrus 湖北宣恩县 李洪钧 3987
O.sarmentosus 云南缅宁县 T.T.Yu 17956
O.peliosanthoides 贵州安龙县 贵州队 2373
O.tienensis 云南澜沧县 C.W.Wang 76478
O.amblyphyllus 四川荥经县 C.W.Yao 2251
O.chingii 贵州盘县八大山 安顺队 941
O.clavatus 贵州雷山县 简焯坡等 50641
O.pingbienensis 云南屏边县 毛品一 4134
O.revolutus 云南车里县 C.W.Wang 78065
O.corifolius 贵州兴龙县 贵州队 3035
O.intermedius 贵州兴仁县 党成忠 092
O.japonicus 四川峨山万年寺 孙祥钟等 872
O.dracaenoides 云南西畴县 K.M.Feng 11573
O.tokinensis 云南西畴县 K.M.Feng 11946
O.xylorrhizus 云南昆洛公路上 昆明工作站 8168
O.reversus 海南定安县 梁向日 64266
O.umbraticola 江西庐山 汪发缵
O.zingiberaceus 四川金阳县 经济植物采集队 3076
O.fooningensis 云南富宁县 C.W.Wang 89114
O.tsaii 云南文山县 K.M.Feng 11085
O.sylvicolus 四川峨眉山 邢么侠等 0648
O.platyphyllus 海南保亭县 吊罗山队 2816
O.grandis 云南顺宁县 T.T.Yu 16214
O.glaucifolius 广西龙津县大青山 陈少卿 11587
O.szechuanensis 四川沐川县 南水北调队 姜恕 07673
O.bockianus 云南黑龙潭 中苏队 1705
O.bockianus var. angustifolius 四川峨眉山 邢么侠、郎楷永 486
O.mairei 四川南川县金佛山 四川队关克俭等 1147
O.bodinieri 四川天全县 方文培 37558
O.wallichianus 贵州威宁县 毕节队 138
Liriope minor 江苏 Y.L.Keng 2406
L.longipedicellata 四川城口县 戴天伦 101157
L.graminifolia 四川 郑万钧 2632
L.kansuensis 四川天全县 李馨 77599
L.spicata 四川巫山 T.P.Wang 10511
L.platyphylla 安徽 P.C.Tsoong 3692
Peliosanthes ophiopogonoides 云南 王孝 100284
P.macrostegia 四川城口县 103086
P.teta 海南万宁县 高锡朋 52123
P.sinica 云南镇越县 C.W.Wang 80030

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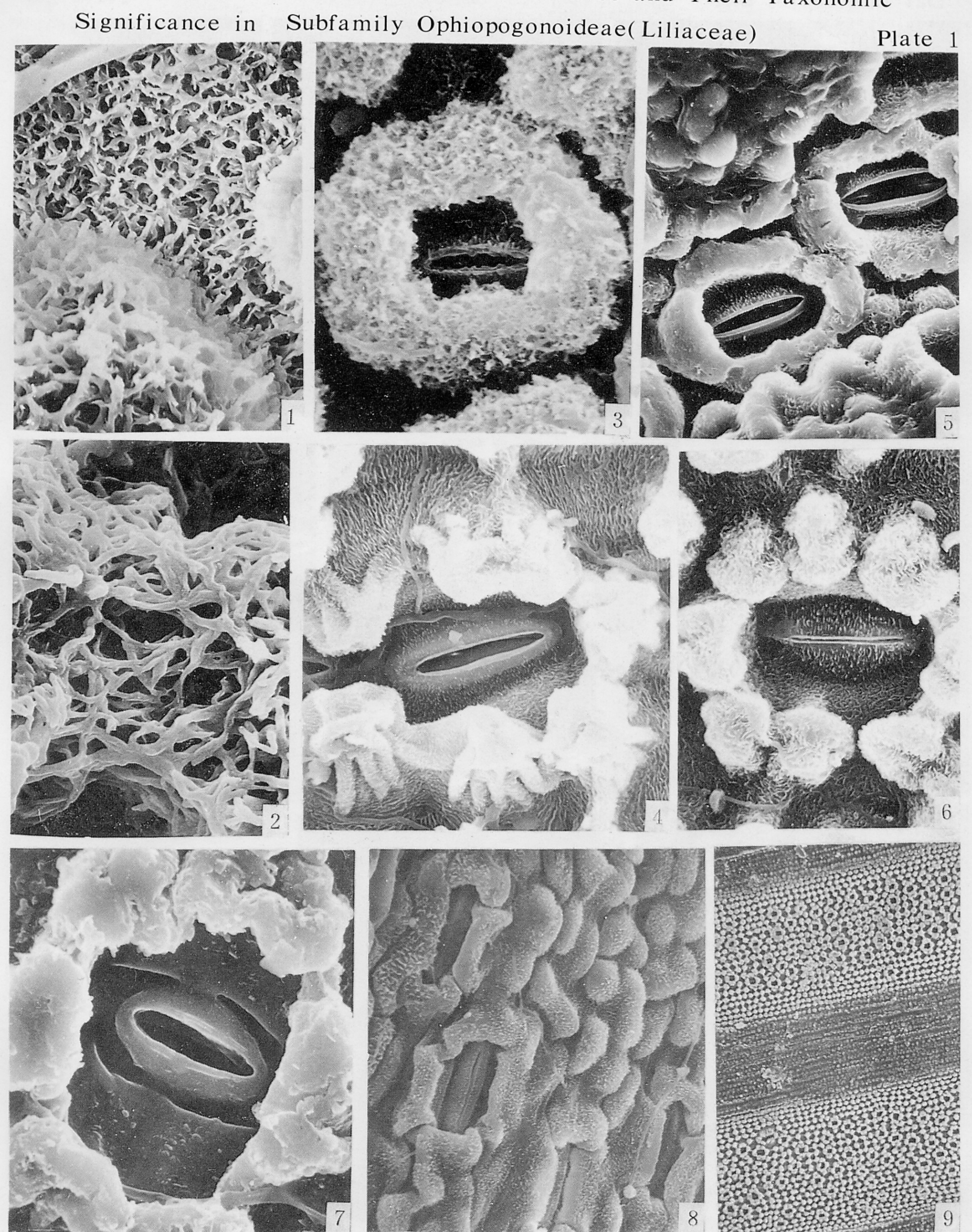
图版说明 Explanation of plates

Plate 1—Plate 3: 示气孔器及其表面角质突起 showing the stomatal apparatus and cuticular processes on the surface.

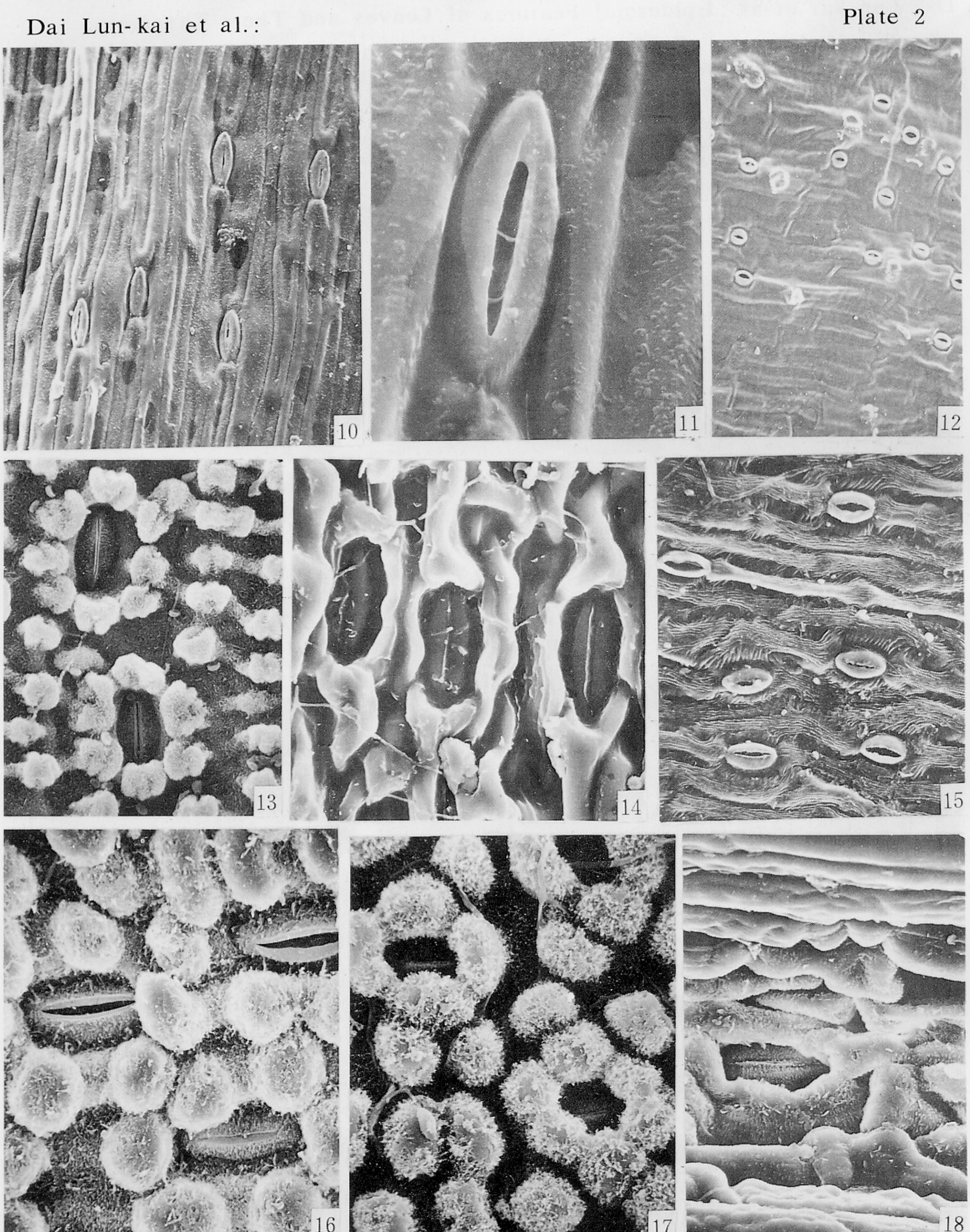
Plate 1 1—2. 示细纤维结构 showing the fibriform structure. 1. *Ophiopogon chingii* × 4800, 2. *O.tienensis* × 6000; 3. *O.intermedius* × 1837; 4.*O.szechuanensis* × 1286; 5.*O.wallichianus* × 810; 6. *O.glaucifolius* × 1154; 7.*O.dracaenoides* × 2308; 8. *Liriope longipedicellata* × 634; 9. *O.szechuanensis* 示气孔带 showing the stomatal band × 60. *g g*

Plate 2 10— 11 *Liriope spicata* 10.× 300, 11.× 1800; 12.*Peliosanthes macrostegia* × 118; 13.*Ophiopogon laucifolius* × 600; 14.*Liriope graminifolius* × 625; 15.*Peliosanthes sinica* × 237; 16.*Ophiopogon japonicus* × 928; 17.*O.chingii* × 810; 18.*O.bodinieri* × 625.

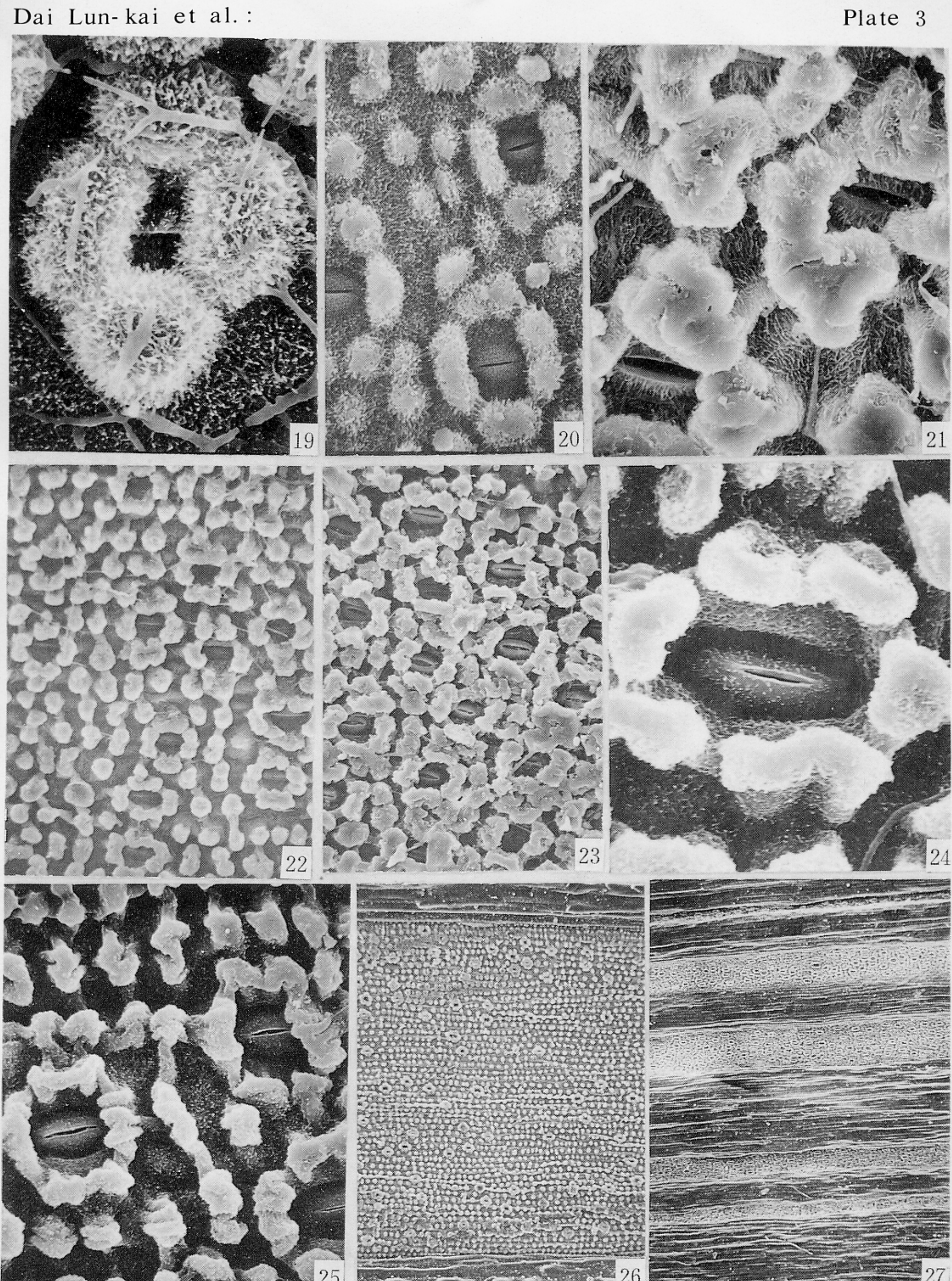
Plate 3 19. *Ophiopogon corifolius* × 1500; 20.*O.heterandrus* × 643; 21.*O.fooningensis* × 1216; 22. *O. sylvicolus* × 300; 23. *O.tonkinensis* × 310; 24.*O.* × *ylorrhizus* × 1429; 25.*O.mairei* × 756; 26—27.示气孔带 showing the stomatal band, 26.*O.tienensis* × 64, 27.*Liriope longipedicellata* × 32.



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